AN ANALYSIS OF THE AQUATIC INVERTEBRATES AND HABITAT OF CAMP CREEK, GALLATIN COUNTY, MONTANA

August 2001

FINAL

A report to

The Montana Department of Environmental Quality
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by

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INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in August 2001 from two sites on Camp Creek, in Gallatin County, Montana. Aquatic invertebrate assemblages were sampled by personnel of the Montana Department of Environmental Quality (DEQ). Study sites lie within the Montana Valley and Foothill Prairies (MVFP) ecoregion (Woods et al. 1999). A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is " ...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1995). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998). The first of these is an appropriate stratification or classification of stream sites, typically, by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied is needed to assist in the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat parameters and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998) has recently studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion, and has recommended a battery of metrics applicable to the montane ecoregions of western Montana. This metric battery has been shown to be sensitive to impairment, related to habitat assessment parameters, and consistent over replicated samples.

Habitat assessment enhances the interpretation of biological data (Barbour and Stribling 1991), because there is generally a direct response of the biological community to habitat degradation in the absence of water quality impairment. If biotic health appears more damaged than the habitat quality would predict, water pollution by metals, other toxicants, high water temperatures, or high levels of organic and/or nutrient pollution might be suspected. On the other hand, an "artificial" elevation of biotic condition in the presence of habitat degradation may be due to the paradoxical effect of mild nutrient or organic enrichment in an oligotrophic setting.

METHODS

Aquatic invertebrates were sampled by Montana DEQ personnel on August 15, 2001. Two sites were sampled. Site locations and sampling dates are indicated in Table 1. The sampling method employed was that recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). In addition to aquatic invertebrate sample collection, habitat quality was visually evaluated at each site and reported by means of the habitat assessment protocols recommended by Bukantis (1998).

Evaluated habitat features include instream conditions, larger-scale channel conditions including flow status, streambank condition, and extent of the riparian zone. Scores were assigned in the field to each habitat measure, and these scores were totaled and compared to the maximum possible score to give an overall assessment of habitat.

Aquatic invertebrate samples and associated habitat data were delivered to Rhithron Biological Associates, Missoula, Montana, for laboratory and data analyses. In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities in this study, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998) was used, since these metrics are probably pertinent to the evaluation of Camp Creek. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics, which have been shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics comprising the bioassessment index used in this study were selected because both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998). In addition, they are relevant to the kinds of impacts that are present in Camp Creek drainage. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998). Each of the six metrics developed and tested for western Montana ecoregions is described below.

Table 1. Sampling sites and dates: two sites on Camp Creek. Sites are listed from downstream to upstream.

Site designation	Site description	Sampling Date	GPS Location Lat.	Long.
01	Camp Creek downstream reach: 1 mile upstream of confluence with Baker Creek	8/15/01	45°48'34"N	111°18'40"W
02	Camp Creek upstream: about 8 miles south of Anceny, on Axtel-Anceny Road	8/15/01	45°38'14"N	111°20'57"W

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.
3. **Trichoptera (caddisfly) taxa richness.** Caddisfly taxa richness has been shown to decline when sediment deposition affects their habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.
4. **Number of sensitive taxa.** Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998).
5. **Percent filter feeders.** Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* sp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are

considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. Percent tolerant taxa. Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery.

Table 2. Metrics and scoring criteria for bioassessment of streams of western Montana ecoregions (Bollman 1998).

	Score			
metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 – 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 – 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 – 35	> 35

The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3a.

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman, unpublished data). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).
- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman, unpublished data).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman, unpublished data).

Table 3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis, 1997).	
% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated
Table 3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).	
% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

RESULTS

Habitat assessment

Figure 1 compares habitat assessment results for the 2 sites in this study. Table 4 itemizes the evaluated habitat parameters and shows the assigned scores for each.

Figure 1. Total habitat assessment scores for sites on Camp Creek, August 2001. Sites are listed from downstream to upstream.

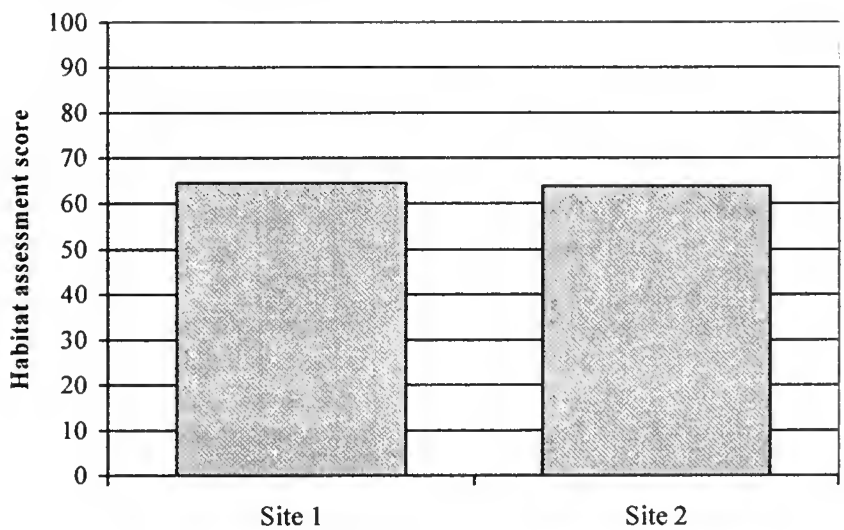


Table 4. Stream and riparian habitat assessment. The downstream site (Site 01) assessment was based upon criteria developed by Montana DEQ for streams with glide/pool prevalence while the upstream site (Site 02) was assessed based upon criteria for streams with riffle/run prevalence. Camp Creek, August 2001.

Max. possible score	**Parameter**	Site 01	Max. possible score	**Parameter**	Site 02
20	Bottom substrate	11	10	Riffle development	8
20	Pool substrate char.	16	10	Benthic substrate	8
20	Pool variability	10	20	Embeddedness	6
20	Channel alteration	16	20	Channel alteration	16
20	Sediment deposition	8	20	Sediment deposition	7
20	Channel sinuosity	10	20	Channel flow status	14
20	Channel flow status	18	20	Bank stability	6 / 6
20	Bank vegetation	8 / 8	20	Bank vegetation	8 / 8
20	Bank stability	6 / 6	20	Vegetated zone	8 / 8
20	Vegetated zone	6 / 6			
200	Total	129	160	Total	103
	Percent of maximum	**64.5**		Percent of maximum	**64**
	CONDITION*	**Sub-optimal**		CONDITION*	**Sub-optimal**

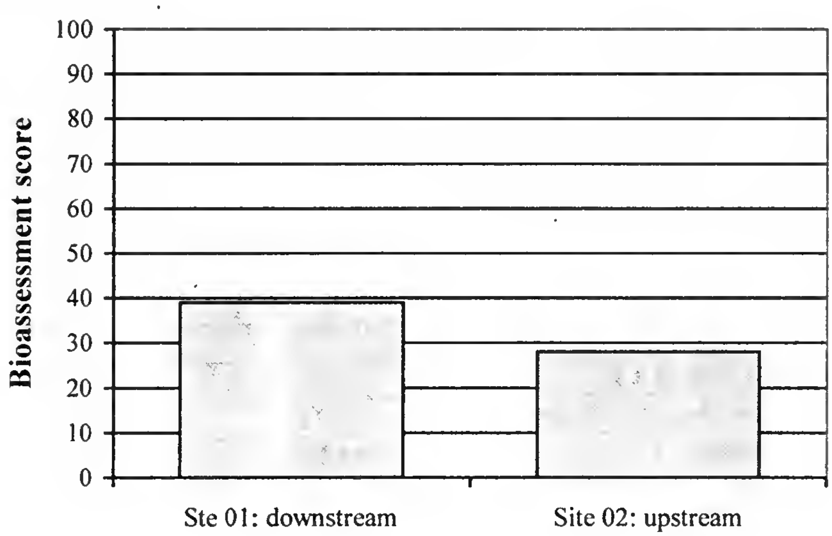
* Condition categories: Optimal (OPT) > 80% of maximum score; Sub-optimal 75 - 56%; Marginal (MARG) 49 - 29%; Poor <23%. Adapted from Plafkin et al. 1988.

Habitat was judged sub-optimal at both Camp Creek sites.

Bioassessment

Macroinvertebrate taxa lists, metric results, and other information for each sample are given in the Appendix. Figure 2 compares the total bioassessment scores calculated for macroinvertebrate communities collected at both sites. Breakdown of scores for each metric calculated from Camp Creek aquatic invertebrate samples is presented in Table 5.

Figure 2. Total bioassessment scores, expressed as percent of maximum, for three sites on Camp Creek, August 2001. Scores are based on the revised metrics for the MVFP ecoregion (Bollman 1998).



Partial support of designated uses was indicated by bioassessment scores for both sites on Camp Creek, based on this analysis of the aquatic invertebrate assemblages. Scores suggested that biotic health was moderately impaired at both sites.

At the downstream site (Site 1), no sensitive taxa were present in the sample, and the relative abundances of both tolerant taxa and filter-feeders were higher than expected. The Ephemeroptera taxa richness was lower than expected for a valley stream. At the upstream site, the Ephemeroptera taxa richness was very low. No Plecoptera or sensitive taxa were present in the sample. The abundance of tolerant taxa exceeded expectations.

Aquatic invertebrate communities

The high biotic index value (4.52) coupled with low mayfly taxa richness suggest that water quality impairment limits the biotic potential at the lower site (01) on Camp Creek. Impairment reflected in these 2 measures may take the form of nutrient enrichment or temperature elevation, and either source of degradation appears possible based on the taxonomic composition of the sample. No cold stenotherms were present, and several taxa were collected that prefer warmer water, such as the caddisflies *Helicopsyche borealis* and *Amiocentrus aspilus*. The large proportion of tolerant taxa in

Table 5. Metric values and bioassessments for Camp Creek, August 2001, based on the revised metric battery for the MVFP ecoregion.

	SITES	
	Site 01: downstream	Site 02: upstream
METRICS	**METRIC VALUES**	
Ephemeroptera richness	3	1
Plecoptera richness	2	0
Trichoptera richness	5	3
Number of sensitive taxa	0	0
Percent filterers	32	1
Percent tolerant taxa	31	68
	METRIC SCORES	
Ephemeroptera richness	1	0
Plecoptera richness	2	0
Trichoptera richness	3	2
Number of sensitive taxa	0	0
Percent filterers	0	3
Percent tolerant taxa	1	0
TOTAL SCORE (max.=18)	7	5
PERCENT OF MAX.	**39**	**28**
Impairment classification*	**MOD**	**MOD**
USE SUPPORT †	**PART**	**PART**

1. Classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.

*Use support designations: See Table 3a.

the sample adds strength to the hypothesis that water quality impairment existed at this site.

Instream habitat conditions appear to be at least partly impacted by fine sediment deposition, since a few taxa preferring moderate to heavy sedimentation were collected in the sample. These include the mayfly *Tricorythodes minutus*, which was common in the sample. However, clean, hard substrates were apparently also available, since 12 "clinger" taxa and 5 caddisfly taxa were present. This suggests that while fine sediments may have been apparent to field personnel, they did not totally prohibit colonization by some organisms sensitive to such impacts. Low taxa richness and low predator taxa richness imply that instream habitats were limited to a moderate extent.

The low stonefly taxa richness suggests that reach-scale habitat features may also have been disturbed. These habitat features might include streambank stability, riparian zone function, or alterations to natural channel morphology. Only 3 long-lived taxa were collected, and none of these were particularly abundant, suggesting the possibility that dewatering or other catastrophic events may have interrupted benthic life cycles in Camp Creek.

Functionally, the community appears to have limited a contribution from scraper taxa, which may have been a result of sediment impacts on benthic substrates, but also could be a result of turbid water conditions.

At the upstream site (02), the biotic index value (5.42) was much higher than expected, and mayfly taxa richness consisted of a single species, the ubiquitous *Baetis tricaudatus*. It appears certain that water quality impairment was a factor affecting the benthic assemblage at this site. Tolerant taxa were also abundant; 68% of the sample consisted of such organisms. The abundance of the lymnaeid snail *Fossaria* sp. and the amphipod *Gammarus* sp., which together comprised 45% of the sampled animals, implies warm, enriched water.

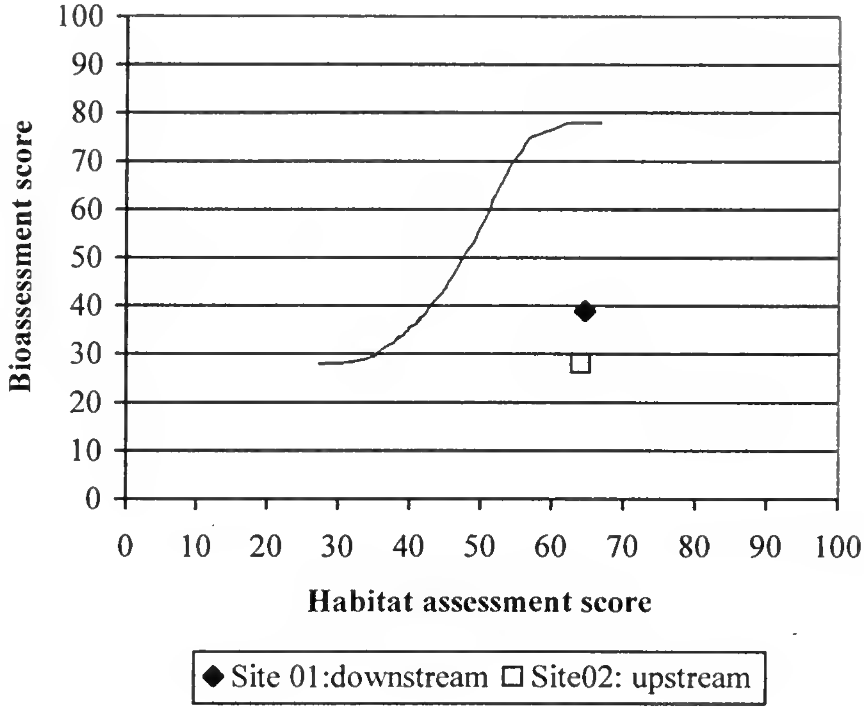
Benthic substrates seem to have been impacted by fine sediment deposition at this site, and sand apparently was a moderate component of substrate materials. The psammophilic midge *Odontomesa* sp. was common in the sample collected here, and other fine-sediment preferring taxa were plentiful. "Clinger" taxa richness (6) was quite low for a valley stream. No stoneflies appeared in the sample, suggesting that reach-level habitat features may have suffered from human disturbance. Long-lived taxa were underrepresented in the benthic fauna; the possibility that dewatering or other catastrophic events may have occurred in this reach cannot be excluded.

Functionally, the assemblage appears to be skewed toward tolerant shredders, suggesting the presence of accumulations of large organic material in slack water areas. Scrapers were lacking, suggesting the impacts of fine sediments on benthic substrates, and/or turbid water conditions.

CONCLUSIONS

- Water quality impairment appears to limit biotic integrity at both sites on Camp Creek. Biotic index values were high, and mayfly taxa richness numbers were low for both sites. Likely sources of impairment are nutrient enrichment and elevated water temperature.
- Both sites appear to be affected by moderate-to-severe sediment deposition, although the downstream site seems to have retained some colonization spaces for "clingers" and caddisflies.
- Evidence for periodic dewatering exists in the taxonomic data from both sites. Long-lived taxa richness is much lower than expected at both sites.
- Reach-scale habitat features, such as streambank stability, natural channel morphology, or riparian zone function, may suffer from human disturbance at both sites.
- The relationship between habitat assessment scores and bioassessment scores is illustrated in Figure 3. The red curve in the center of the graph represents the hypothetical relationship between habitat quality and biotic health when habitat degradation is the sole source of impairment to benthic assemblage health (Barbour and Stribling 1991). Symbols which fall below the line indicate that bioassessment scores are somewhat lower than would be expected if impairment were due to habitat degradation alone, and suggests that water quality impairment, perhaps by elevated temperatures, was the predominant factor limiting biotic health in both reaches of Camp Creek.

Figure 3. Total bioassessment scores plotted against habitat assessment scores for three sites on Camp Creek, August 2001. The red line describes the hypothetical relationship expected when water quality is good and biotic health is determined predominantly by habitat quality (Barbour and Stribling 1991).



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APPENDIX

Taxonomic data and summaries

Camp Creek

August 2001

Aquatic Invertebrate Taxonomic Data

Site Name: Camp Creek: downstream reach

Site ID: MO5CAMPC01 8/15/01

Approx. percent of sample used: 7.5

Taxon	Quantity	Percent	HBI	FFG
Nais sp.	8	2.42	8	CG
Acari	1	0.30	5	PA
Total Misc. Taxa	**9**	**2.73**		
Baetis tricaudatus	59	17.88	4	CG
Attenella sp.	4	1.21	2	CG
Tricorythodes minutus	25	7.58	4	CG
Total Ephemeroptera	**88**	**26.67**		
Skwala sp.	3	0.91	3	PR
Pteronarcella sp.	8	2.42	0	OM
Total Plecoptera	**11**	**3.33**		
Amiocentrus aspilus	24	7.27	3	CG
Brachycentrus occidentalis	1	0.30	2	OM
Glossosoma sp.	6	1.82	0	SC
Helicopsyche borealis	2	0.61	3	SC
Hydropsyche sp.	101	30.61	5	CF
Total Trichoptera	**134**	**40.61**		
Optioservus sp.	12	3.64	5	SC
Total Coleoptera	**12**	**3.64**		
Simulium sp.	5	1.52	5	CF
Hexatoma sp.	4	1.21	2	PR
Total Diptera	**9**	**2.73**		
Cricotopus (Cricotopus) Gr.	1	0.30	7	CG
Cricotopus Trifascia Gr.	11	3.33	7	CG
Eukiefferiella Devonica Gr.	4	1.21	8	OM
Eukiefferiella Gracei Gr.	5	1.52	8	OM
Eukiefferiella Pseudomontana Gr.	3	0.91	8	OM
Micropsectra sp.	3	0.91	4	CG
Microtendipes sp.	1	0.30	6	CG
Orthocladius sp.	6	1.82	6	CG
Pagastia sp.	4	1.21	1	CG
Parametriocnemus sp.	2	0.61	5	CG
Polypedilum sp.	7	2.12	6	OM
Thienemanniella sp.	3	0.91	6	CG
Tvetenia sp.	17	5.15	5	CG
Total Chironomidae	**67**	**20.30**		
Grand Total	**330**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Camp Creek: downstream reach

Site ID: MO5CAMPC01 8/15/01

TOTAL ABUNDANCE	330
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	233
TOTAL NUMBER OF TAXA	28
Number EPT taxa	10

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	2	9	2.73
Odonata	0	0	0.00
Ephemeroptera	3	88	26.67
Plecoptera	2	11	3.33
Hemiptera	0	0	0.00
Megaloptera	0	0	0.00
Trichoptera	5	134	40.61
Lepidoptera	0	0	0.00
Coleoptera	1	12	3.64
Diptera	2	9	2.73
Chironomidae	13	67	20.30

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	3.48

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	2	7	2.12
Parasite	1	1	0.30
Collector-gatherer	14	168	50.91
Collector-filterer	2	106	32.12
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	0	0	0.00
Scraper	3	20	6.06
Shredder	0	0	0.00
Xylophage	0	0	0.00
Omnivore	6	28	8.48
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	0.19
Scraper/(Scraper + C.filterer)	0.16
Shredder/Total organisms	0.00

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Hydropsyche sp.	101	30.61
Baetis tricaudatus	59	17.88
Tricorythodes minutus	25	7.58
Amiocentrus aspilus	24	7.27
Tvetenia sp.	17	5.15
SUBTOTAL 5 DOMINANTS	226	68.48
Optioservus sp.	12	3.64
Cricotopus Trifascia Gr.	11	3.33
Nais sp.	8	2.42
Pteronarcella sp.	8	2.42
Polypedilum sp.	7	2.12
TOTAL DOMINANTS	272	82.42

SAPROBIC INDICES

Hilsenhoff Biotic Index	4.52

DIVERSITY MEASURES

Shannon H (loge)	2.14
Shannon H (log2)	3.08
Evenness	0.64
Simpson D	0.12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	121	36.59
Univoltine	188	57.05
Semivoltine	21	6.36

	#TAXA	ABUNDANCE	PERCENT
Tolerant	5	101	30.61
Intolerant	0	0	0.00
Clinger	12	182	55.15

Aquatic Invertebrate Taxonomic Data

Site Name: Camp Creek: upstream near headwaters
Site ID: MO5CAMPC02 8/15/01

Approx. percent of sample used: 17

Taxon	Quantity	Percent	HBI	FFG
Nais sp.	1	0.31	8	CG
Eiseniella tetraedra	1	0.31	8	CG
Sphaeriidae	25	7.76	8	CG
Fossaria sp.	1	0.31	6	CG
Physidae	47	14.60	8	CG
Ostracoda	1	0.31	8	CG
Gammarus sp.	96	29.81	4	SH
Total Misc. Taxa	**172**	**53.42**		
Baetis tricaudatus	15	4.66	4	CG
Total Ephemeroptera	**15**	**4.66**		
Sigara sp.	10	3.11	5	PH
Total Hemiptera	**10**	**3.11**		
Hydropsyche sp.	3	0.93	5	CF
Hydroptila sp.	32	9.94	6	PH
Hesperophylax sp.	1	0.31	3	SH
Total Trichoptera	**36**	**11.18**		
Dytiscidae	9	2.80	5	PR
Heterlimnius sp.	4	1.24	3	CG
Lara avara	1	0.31	1	SH
Optioservus sp.	10	3.11	5	SC
Total Coleoptera	**24**	**7.45**		
Ceratopogoninae	1	0.31	6	PR
Limnophora sp.	6	1.86	6	PR
Pericoma sp.	2	0.62	4	CG
Tabanidae	1	0.31	6	PR
Tipula sp.	1	0.31	4	OM
Total Diptera	**11**	**3.42**		
Cricotopus Trifascia Gr.	6	1.86	7	CG
Macropelopia sp.	11	3.42	6	PR
Micropsectra sp.	23	7.14	4	CG
Odontomesa sp.	5	1.55	4	CG
Orthocladius sp.	5	1.55	6	CG
Pagastia sp.	1	0.31	1	CG
Tvetenia sp.	3	0.93	5	CG
Total Chironomidae	**54**	**16.77**		
Grand Total	**322**	**100.00**		

Aquatic Invertebrate Summary Data

Site Name: Camp Creek: upstream near headwaters

Site ID: MO5CAMPC02 8/15/01

TOTAL ABUNDANCE	322
Ephemeroptera + Plecoptera + Trichoptera (EPT) abundance	51
TOTAL NUMBER OF TAXA	28
Number EPT taxa	4

TAXONOMIC GROUP COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Misc. Taxa	7	172	53.42
Odonata	0	0	0.00
Ephemeroptera	1	15	4.66
Plecoptera	0	0	0.00
Hemiptera	1	10	3.11
Megaloptera	0	0	0.00
Trichoptera	3	36	11.18
Lepidoptera	0	0	0.00
Coleoptera	4	24	7.45
Diptera	5	11	3.42
Chironomidae	7	54	16.77

RATIOS OF TAX GROUP ABUNDANCES

EPT/Chironomidae	0.94

FUNCTIONAL FEEDING GROUP (FFG) COMPOSITION

GROUP	#TAXA	ABUNDAN	PERCENT
Predator	5	28	8.70
Parasite	0	0	0.00
Collector-gatherer	15	140	43.48
Collector-filterer	1	3	0.93
Macrophyte-herbivore	0	0	0.00
Piercer-herbivore	2	42	13.04
Scraper	1	10	3.11
Shredder	3	98	30.43
Xylophage	0	0	0.00
Omnivore	1	1	0.31
Unknown	0	0	0.00

RATIOS OF FFG ABUNDANCES

Scraper/Collector-filterer	3.33
Scraper/(Scraper + C.filterer)	0.77
Shredder/Total organisms	0.09

CONTRIBUTION OF DOMINANT TAXA

TAXON	ABUNDANCE	PERCENT
Gammarus sp.	96	29.81
Physidae	47	14.60
Hydroptila sp.	32	9.94
Sphaeriidae	25	7.76
Micropsectra sp.	23	7.14
SUBTOTAL 5 DOMINANTS	223	69.25
Baetis tricaudatus	15	4.66
Macropelopia sp.	11	3.42
Sigara sp.	10	3.11
Optioservus sp.	10	3.11
Dytiscidae	9	2.80
TOTAL DOMINANTS	278	86.34

SAPROBIC INDICES

Hilsenhoff Biotic Index	5.42

DIVERSITY MEASURES

Shannon H (loge)	2.10
Shannon H (log2)	3.03
Evenness	0.63
Simpson D	0.12

COMMUNITY VOLTINISM ANALYSIS

TYPE	ABUNDANCE	PERCENT
Multivoltine	78	24.07
Univoltine	208	64.60
Semivoltine	37	11.34

	#TAXA	ABUNDANCE	PERCENT
Tolerant	10	218	67.70
Intolerant	0	0	0.00
Clinger	6	56	17.39